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Sozawa et al.

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(54) **IMAGE PROCESSING DEVICE**

(56) **References Cited**

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U.S.C. 154(b) by 0 days.

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(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Nov. 27, 2020 (JP) JP2020-197281

An image processing device includes a light receiving element, a light emitting element, a battery, a power source circuit electrically coupled to the battery, an operation section, a wireless communication module, a first substrate provided with the light receiving element, a second substrate provided with the light emitting element, a third substrate provided with the power source circuit, a fourth substrate provided with the wireless communication module and the operation section, and a casing storing the first substrate, the second substrate, the third substrate, and the fourth substrate, in which the second substrate is fixed to the first substrate, and the first substrate is fixed to the casing.

(51) **Int. Cl.**
H04N 5/225 (2006.01)

(52) **U.S. Cl.**
CPC **H04N 5/2256** (2013.01); **H04N 5/2252**
(2013.01)

(58) **Field of Classification Search**
CPC ... H04N 5/2252; H04N 5/2253; H04N 5/2256
See application file for complete search history.

5 Claims, 10 Drawing Sheets

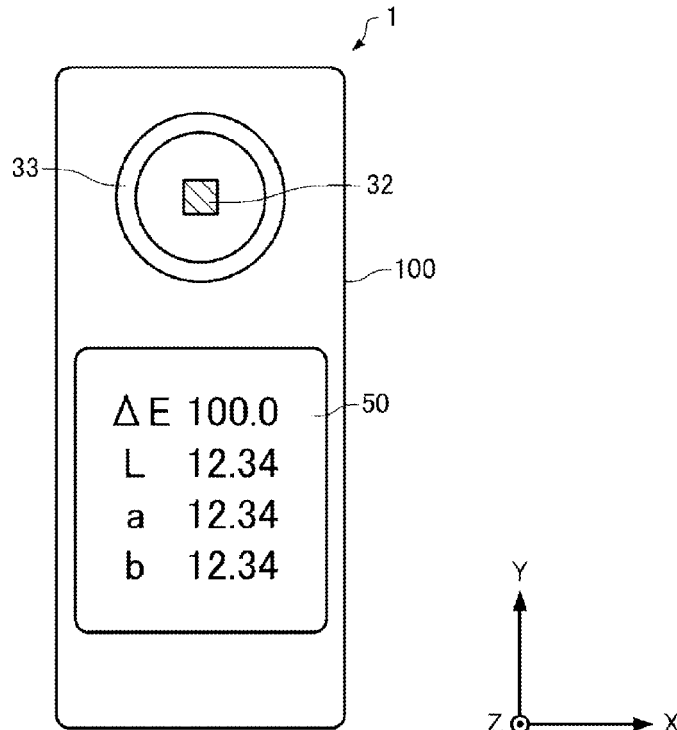


FIG. 1

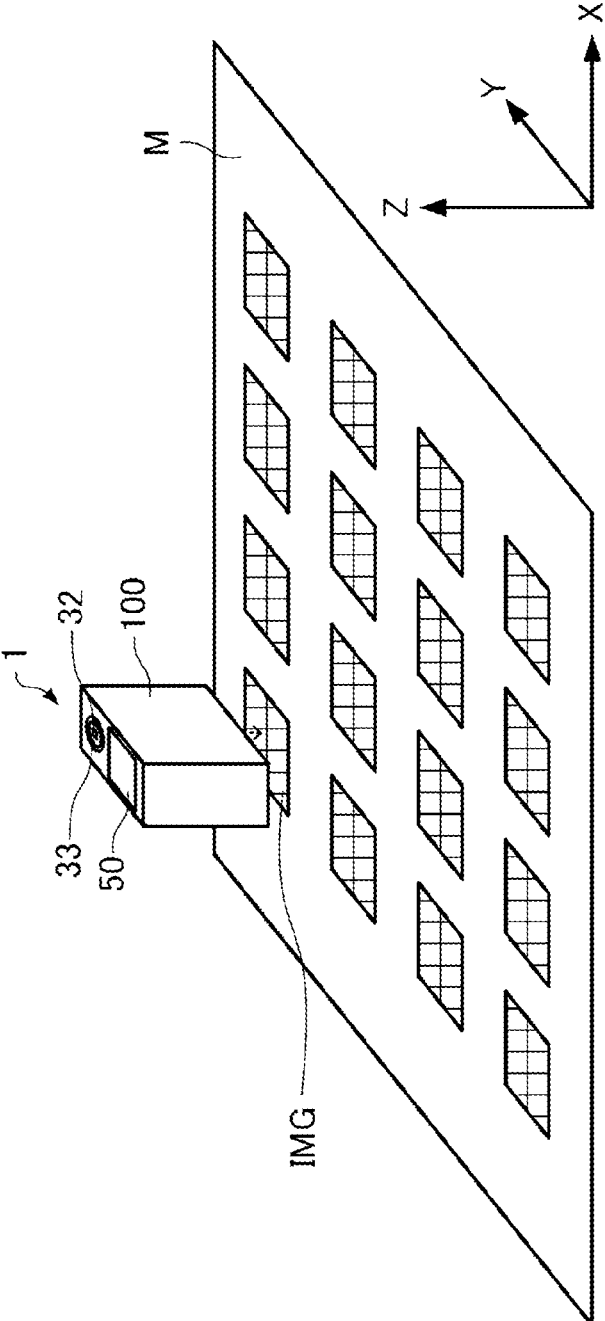
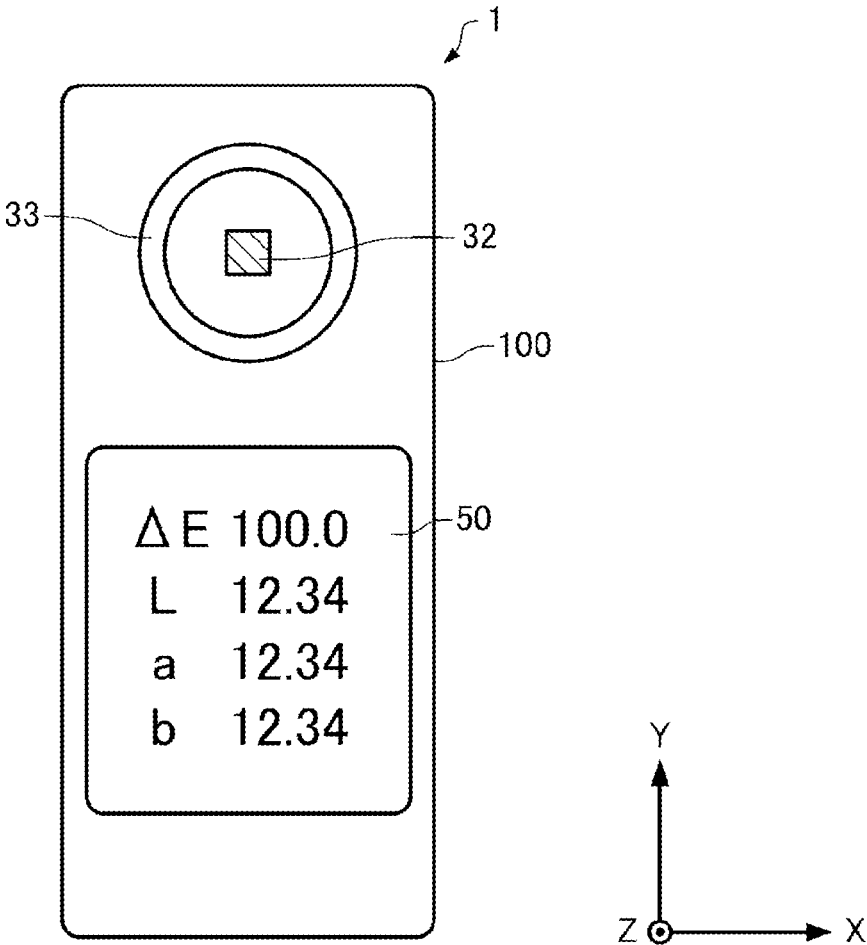


FIG. 2



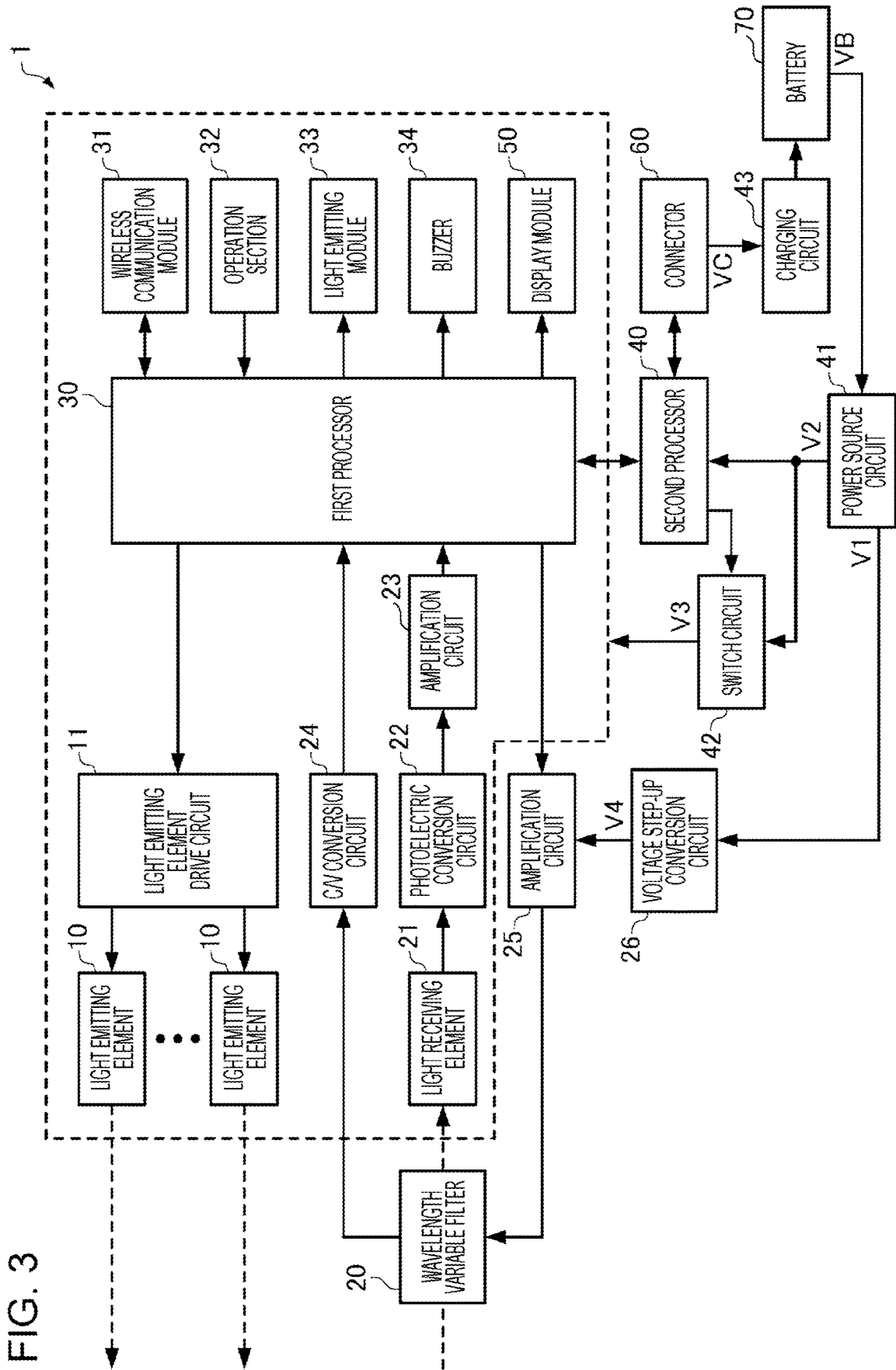


FIG. 3

FIG. 5

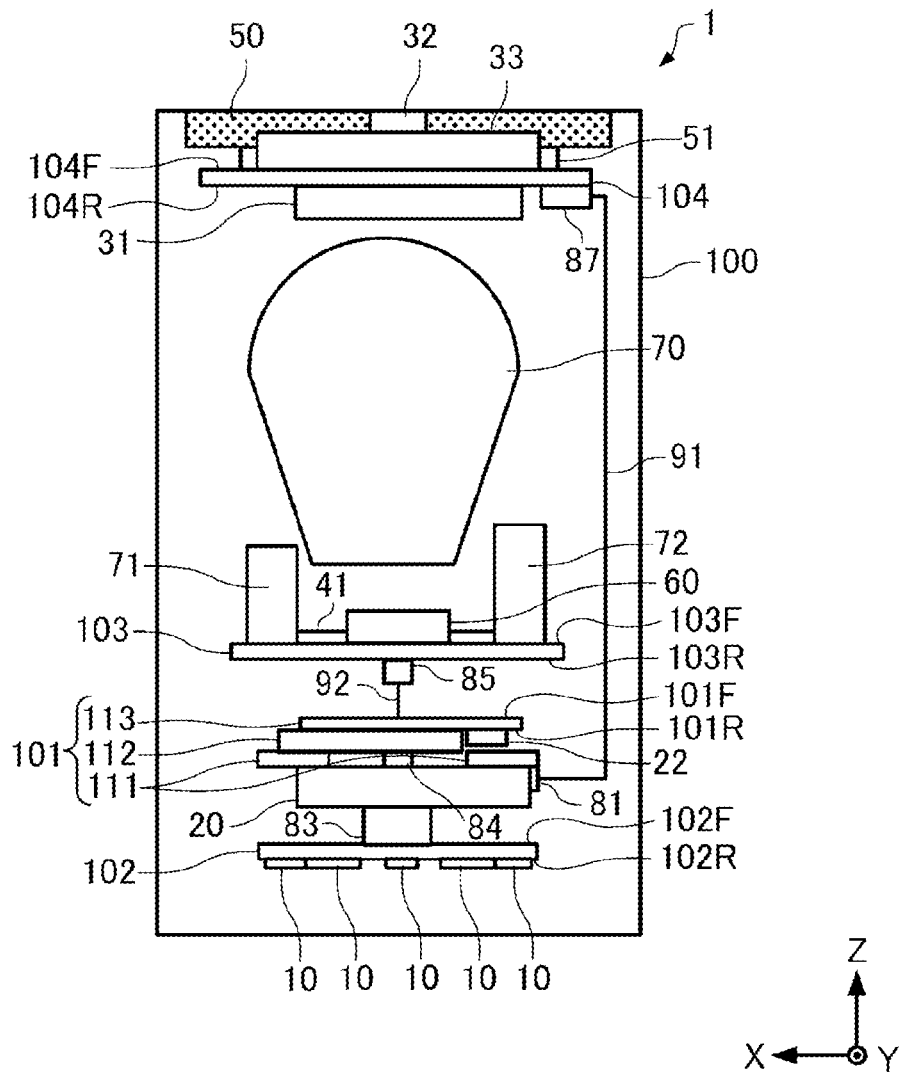


FIG. 6

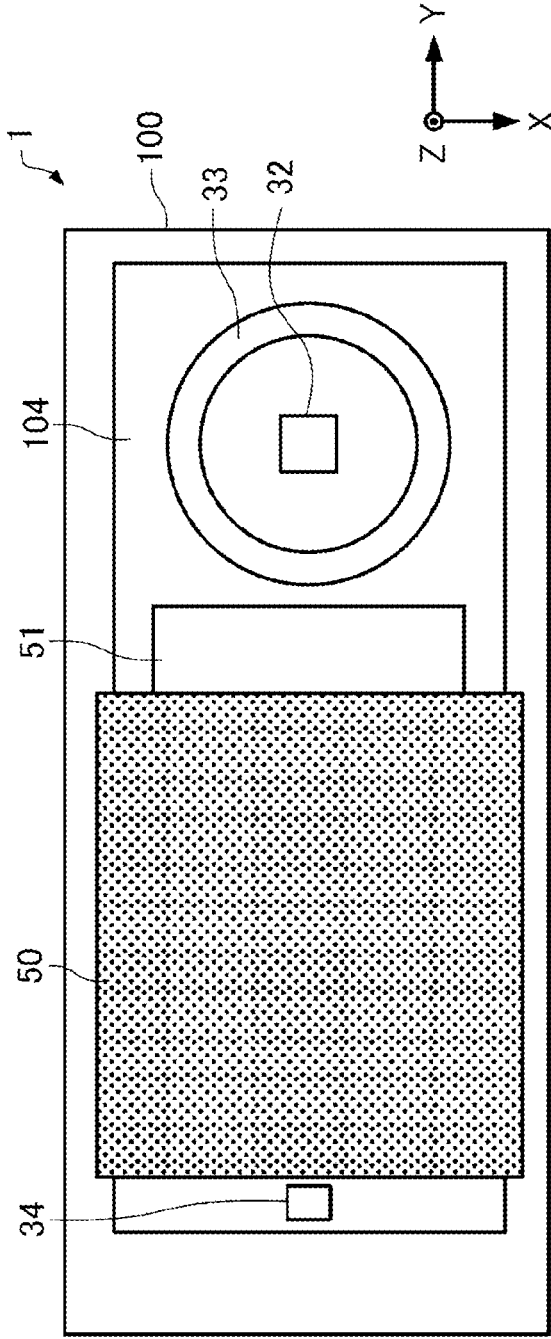


FIG. 7

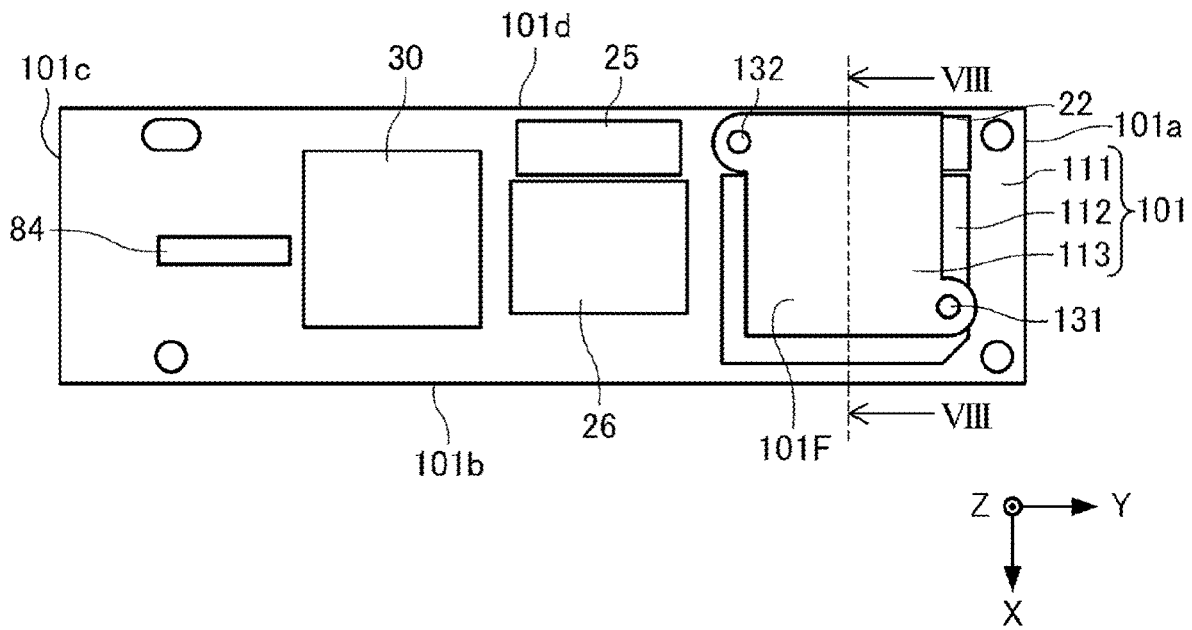


FIG. 8

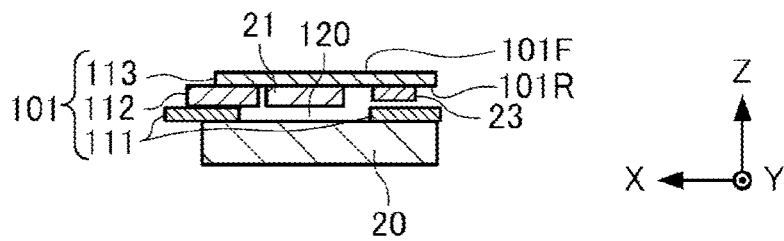


FIG. 9

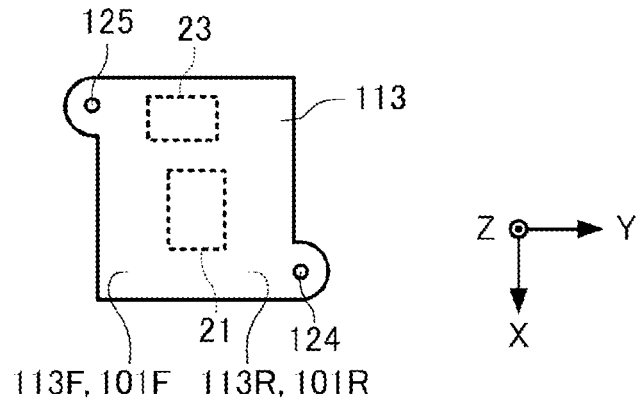


FIG. 10

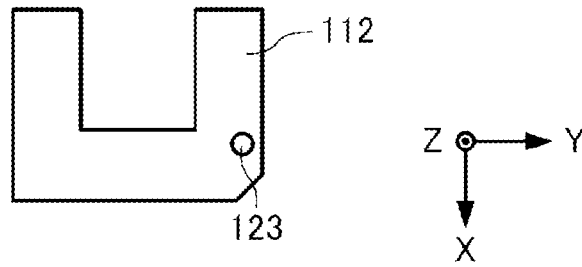


FIG. 11

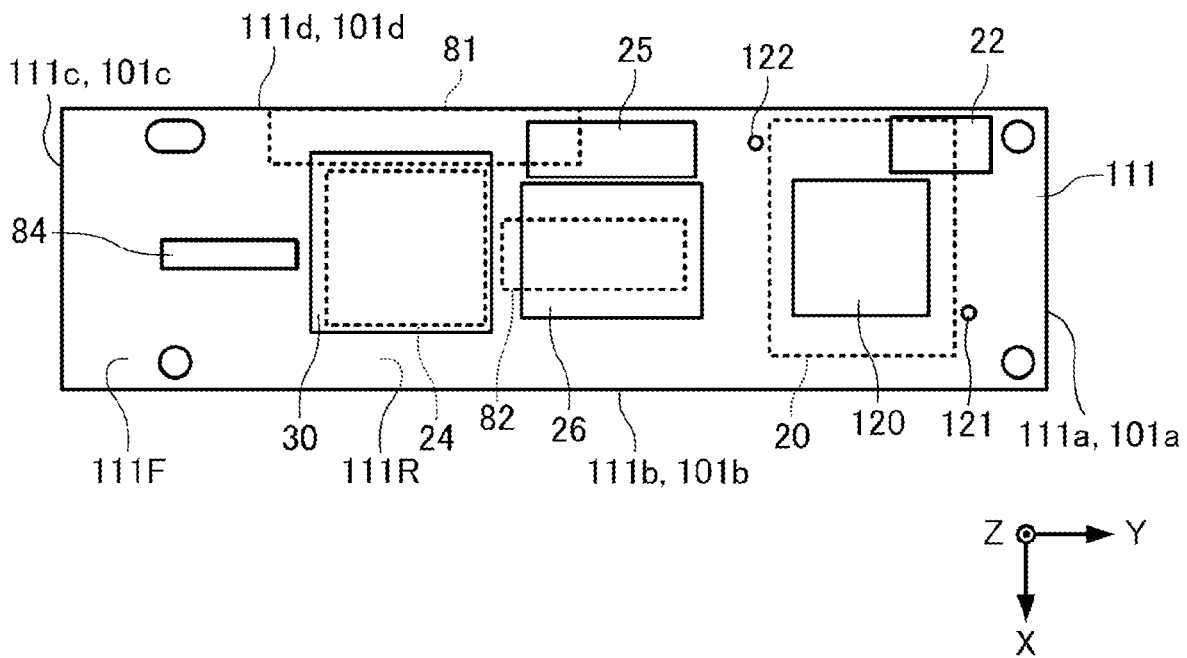


FIG. 12

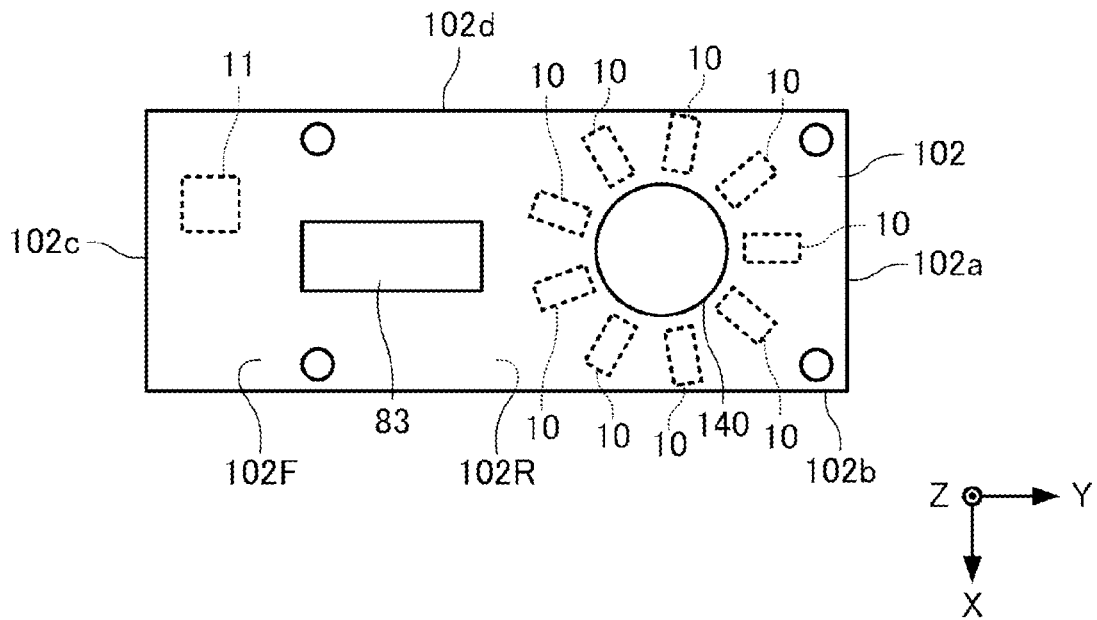


FIG. 13

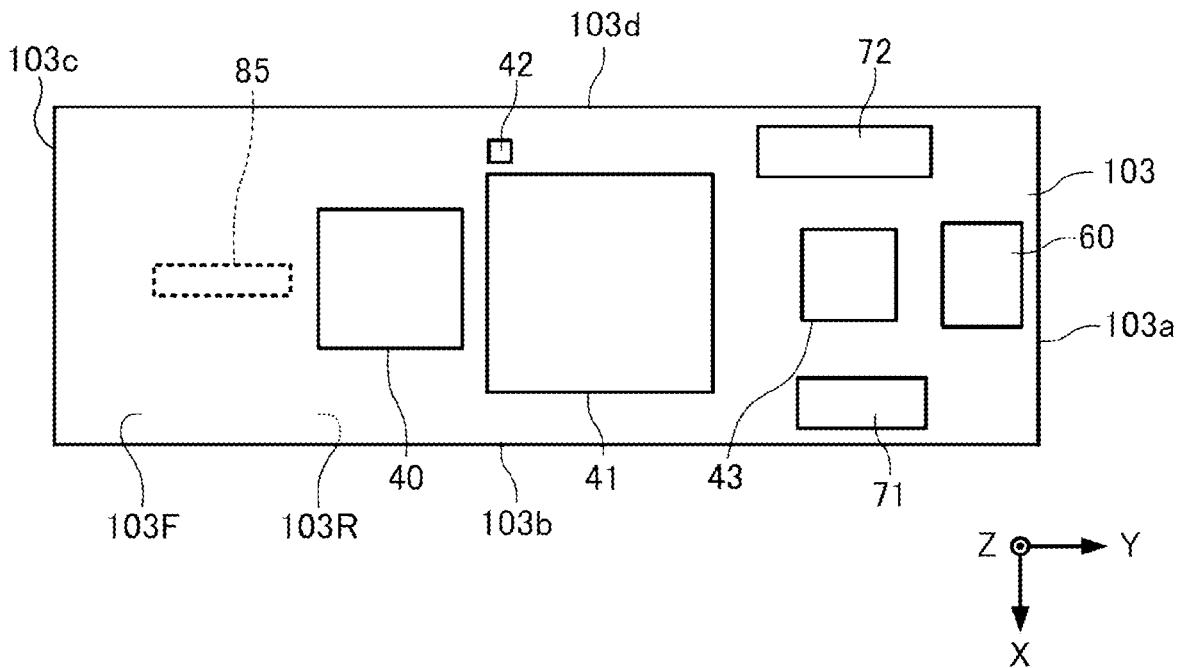


FIG. 14

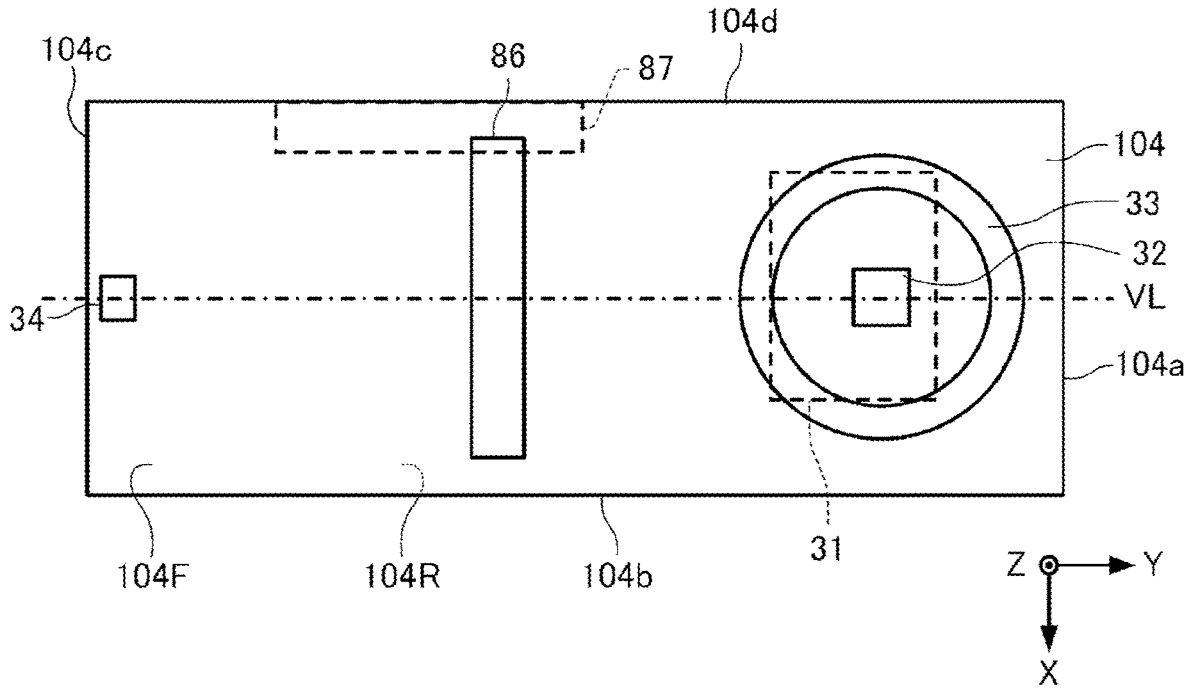
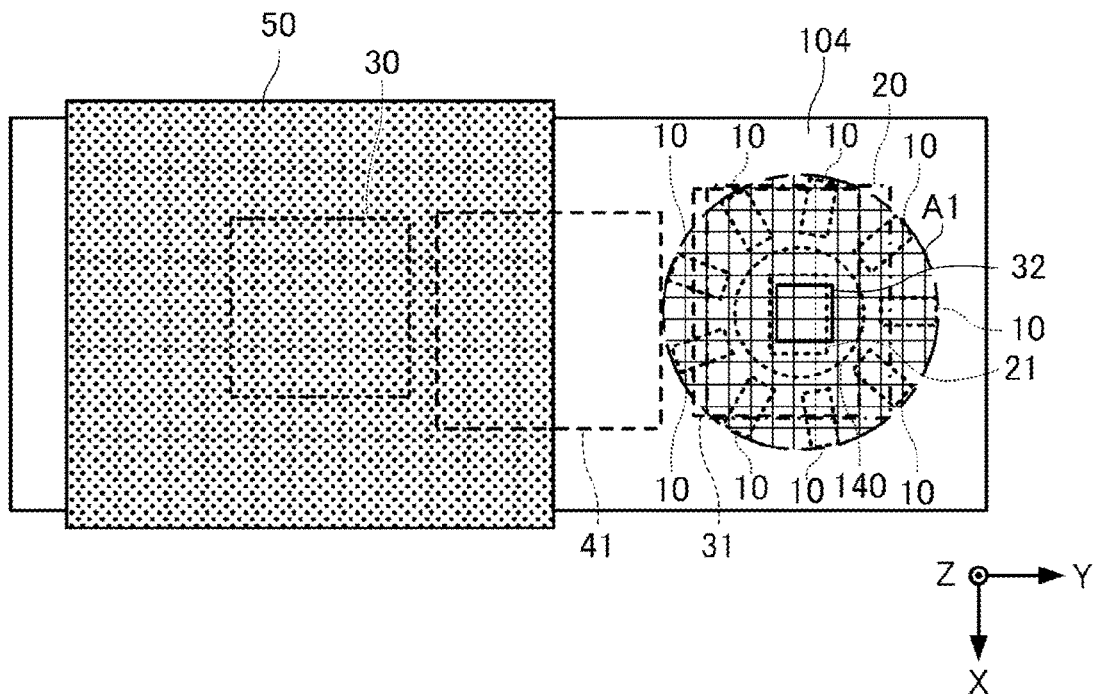


FIG. 15



1

IMAGE PROCESSING DEVICE

The present application is based on, and claims priority from JP Application Ser. No. 2020-197281, filed Nov. 27, 2020, the disclosure of which is hereby incorporated by reference herein in its entirety.

BACKGROUND

1. Technical Field

The present disclosure relates to an image processing device.

2. Related Art

In recent years, image processing devices provided with a battery and capable of being carried and operated independently have become widespread. For example, JP-A-2010-81057 discloses an image processing device including a calibration data setting section that sets, as calibration data, color chart image data in a temperature near to a temperature at the time of imaging a subject among temperatures between a temperature of an imaging device at the time of imaging a color chart before imaging the subject and a temperature of the imaging device at the time of imaging the color chart after imaging the subject, based on a temperature of the imaging device when the imaging device images the subject, temperatures of the imaging device at the time of imaging the color chart before and after imaging the subject, and color chart image data acquired by imaging the color chart before and after imaging the subject; and an image correction section that corrects image data of the subject acquired by imaging the subject by using the calibration data set by the calibration data setting section. According to the image processing device disclosed in JP-A-2010-81057, image data of a subject can be accurately corrected even when imaging conditions and the like vary during imaging.

However, in an image processing device provided with a battery and capable of being carried or operated independently, since various constituents are disposed in a small casing, there is concern that mutual interference of heat, vibration, signals, and the like may occur between a plurality of constituents and thus the accuracy of image processing may decrease depending on disposition of the plurality of constituents such as various circuits and components such that there is still room for technical improvement.

SUMMARY

According to an aspect of the present disclosure, there is provided an image processing device including a light receiving element; a light emitting element; a battery; a power source circuit electrically coupled to the battery; an operation section; a wireless communication module; a first substrate provided with the light receiving element; a second substrate provided with the light emitting element; a third substrate provided with the power source circuit; a fourth substrate provided with the wireless communication module and the operation section; and a casing storing the first substrate, the second substrate, the third substrate, and the fourth substrate, in which the second substrate is fixed to the first substrate, and the first substrate is fixed to the casing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an image processing device of the present embodiment.

2

FIG. 2 is a diagram illustrating an example of information displayed on a display module.

FIG. 3 is a block diagram illustrating a functional configuration of an image processing device.

FIG. 4 is a diagram in which the inside of a casing of the image processing device is viewed from a positive direction of an X axis.

FIG. 5 is a diagram in which the inside of the casing of the image processing device is viewed from a positive direction of a Y axis.

FIG. 6 is a diagram in which the inside of the casing of the image processing device is viewed from a positive direction of a Z axis.

FIG. 7 is a diagram in which a first substrate is viewed from the positive direction of the Z axis.

FIG. 8 is a sectional view of the first substrate taken along the line VIII-VIII in FIG. 7.

FIG. 9 is a diagram in which a sub-substrate is viewed from the positive direction of the Z axis.

FIG. 10 is a diagram in which a spacer substrate is viewed from the positive direction of the Z axis.

FIG. 11 is a diagram in which a main substrate is viewed from the positive direction of the Z axis.

FIG. 12 is a diagram in which the second substrate is viewed from the positive direction of the Z axis.

FIG. 13 is a diagram in which a third substrate is viewed from the positive direction of the Z axis.

FIG. 14 is a diagram in which the fourth substrate is viewed from the positive direction of the Z axis.

FIG. 15 is a diagram in which some constituents of the image processing device are viewed from the positive direction of the Z axis.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

Hereinafter, preferred embodiments of the present disclosure will be described in detail with reference to the drawings. The drawings used are for convenience of description. The embodiments described below do not unreasonably limit the content of the present disclosure described in the claims. Moreover, not all of the configurations described below are essential constituent requirements of the present disclosure.

Hereinafter, in the present embodiment, a color measurement device will be described as an example of an image processing device according to the present disclosure.

1. Outline of Image Processing Device

FIG. 1 is a perspective view of an image processing device 1 of the present embodiment. As illustrated in FIG. 1, the image processing device 1 of the present embodiment performs a color measurement process for measuring a color of an image IMG as image processing. Specifically, when a user moves the image processing device 1 onto an image IMG formed on a medium M and presses an operation section 32 disposed on an upper surface of the image processing device 1, the image processing device 1 emits light from a part of a bottom surface facing the image IMG, and measures a color of the image IMG based on a wavelength of the light reflected at the image IMG. That is, the operation section 32 functions as a measurement start button. For example, the medium M is paper or cloth, and the image IMG is a monochromatic image. As illustrated in FIG. 1, a color chart including a plurality of images having different colors may be formed on the medium M, and the user may move the image processing device 1 onto each image and presses the operation section 32 such that the

image processing device **1** measures a color of each image. The image processing device **1** may also measure a color of the medium **M**.

The image processing device **1** may calculate a color difference that is a difference between a color measurement value and a target color value. The image processing device **1** displays the calculated color measurement value or color difference on a display module **50** that can be visually recognized by the user from the outside of a casing **100**. In the example in FIG. **1**, the display module **50** is provided at a position visually recognizable to the user from the surface on which the operation section **32** of the image processing device **1** is disposed. FIG. **2** is a diagram illustrating an example of a color measurement value and a color difference displayed on the display module **50**. In the example in FIG. **2**, color measurement values L , a , and b and a color difference ΔE displayed on the display module **50** are values in an $L^*a^*b^*$ color space. A color measurement value or a color difference may be a value in various color spaces other than the $L^*a^*b^*$ color space, such as an RGB color space, a YCC color space, a CMYK color space, and an L^*C^*h color space.

As illustrated in FIGS. **1** and **2**, the image processing device **1** may have a light emitting module **33** that can be visually recognized by the user from the outside of the casing **100**. In the examples in FIGS. **1** and **2**, the light emitting module **33** is disposed to surround the operation section **32**. For example, the light emitting module **33** has a tubular light guide and an LED attached to a tip of the light guide, and light emitted by the LED is guided to the light guide. LED stands for light emitting diode. In the examples in FIGS. **1** and **2**, the user can visually recognize the light guide of the light emitting module **33**. The light emitting module **33** is a status display module, and a light emitting state differs depending on an operation of the user on the operation section **32**. For example, the image processing device **1** may cause the light emitting module **33** to emit light when it is recognized that the operation section **32** has been pressed by the user.

The image processing device **1** has a shape similar to a rectangular parallelepiped having a size that can be grasped and operated by the user with one hand, and can thus be carried. Since the image processing device **1** has a battery **70** built therein that will be described later and is operated when the user presses the operation section **32**, the image processing device **1** can be operated independently without receiving an instruction from another device. Therefore, the image processing device **1** is highly convenient for the user.

As illustrated in FIGS. **1** and **2**, directions along three intersecting sides of the casing **100** of the image processing device **1** are respectively set to an X axis, a Y axis, and a Z axis. It is hereinafter assumed that a relationship between the directions of the image processing device **1** and the X axis, Y axis, and Z axis is the same as in FIGS. **1** and **2** except FIG. **3**.

2. Functional Configuration of Image Processing Device

FIG. **3** is a block diagram illustrating a functional configuration of the image processing device **1**. As illustrated in FIG. **3**, the image processing device **1** includes a plurality of light emitting elements **10** and a light emitting element drive circuit **11**. The image processing device **1** includes a wavelength variable filter **20**, a light receiving element **21**, a photoelectric conversion circuit **22**, an amplification circuit **23**, a C/V conversion circuit **24**, an amplification circuit **25**, and a voltage step-up conversion circuit **26**. The image processing device **1** includes a first processor **30**, a wireless communication module **31**, an operation section **32**, a light

emitting module **33**, a buzzer **34**, and a display module **50**. The image processing device **1** includes a second processor **40**, a power source circuit **41**, a switch circuit **42**, a charging circuit **43**, a connector **60**, and a battery **70**.

Each of the plurality of light emitting elements **10** is disposed on the bottom surface portion of the image processing device **1**, and is turned on or off based on a drive signal output from the light emitting element drive circuit **11**. When each light emitting element **10** is turned on, light is emitted from the bottom surface of the image processing device **1**. Each light emitting element **10** is, for example, an LED. For example, among the plurality of light emitting elements **10**, some light emitting elements may emit white light, and some other light emitting elements may emit ultraviolet light.

The light emitting element drive circuit **11** outputs a plurality of drive signals for respectively driving the plurality of light emitting elements **10** based on control signals from the first processor **30**.

The wavelength variable filter **20** transmits light having a wavelength in a predetermined range among light beams incident from the bottom surface of the image processing device **1**. The wavelength variable filter **20** includes an electrostatic actuator (not illustrated), and a voltage output from the amplification circuit **25** is applied to the electrostatic actuator. A capacitance value of the electrostatic actuator changes according to the applied voltage, and a wavelength of light transmitted by the wavelength variable filter **20** changes according to the capacitance value of the electrostatic actuator. Therefore, the wavelength of the light transmitted by the wavelength variable filter **20** changes according to the voltage output from the amplification circuit **25**. For example, the wavelength variable filter **20** may be an etalon element.

The amplification circuit **25** outputs a voltage of several tens of V for driving the wavelength variable filter **20**. The output voltage of the amplification circuit **25** changes based on a control signal from the first processor **30**.

The voltage step-up conversion circuit **26** steps up a voltage $V1$ of several V output from the power source circuit **41** to a voltage $V4$ of several tens of V and outputs the voltage $V4$ to the amplification circuit **25**. The voltage $V4$ stepped up by the voltage step-up conversion circuit **26** becomes a power source voltage of the amplification circuit **25**. The voltage step-up conversion circuit **26** may be, for example, a step-up DCDC converter.

The C/V conversion circuit **24** converts electric charge stored in the electrostatic actuator into a voltage and outputs the voltage to the first processor **30**. The first processor **30** controls an output voltage of the amplification circuit **25** based on a digital value obtained by performing A/D conversion on the output voltage of the C/V conversion circuit **24** such that the wavelength variable filter **20** transmits light having a desired wavelength. That is, a wavelength of light transmitted by the wavelength variable filter **20** is controlled by the first processor **30**.

The light receiving element **21** receives the light transmitted through the wavelength variable filter **20** and outputs electric charge having a magnitude corresponding to the amount of light. For example, the light receiving element **21** may be a photodiode.

The photoelectric conversion circuit **22** converts an amount of light received by the light receiving element **21** into an electrical signal and outputs the electrical signal to the amplification circuit **23**. For example, the photoelectric

conversion circuit **22** may be a C/V conversion circuit that converts electric charge output from the light receiving element **21** into a voltage.

The amplification circuit **23** amplifies the voltage output from the photoelectric conversion circuit **22** and outputs the amplified voltage to the first processor **30**.

The first processor **30** is a processor that performs image processing, and generates a digital value indicating an amount of light received by the light receiving element **21** by performing A/D conversion on the output voltage of the photoelectric conversion circuit **22**, and stores the amount of light in association with a wavelength of the light. The first processor **30** may be, for example, an MCU or an MPU. MCU stands for micro control unit, and MPU stands for micro-processing unit. The first processor **30** sweeps the wavelength of the light transmitted by the wavelength variable filter **20**, and stores the amount of light received by the light receiving element **21** in association with each wavelength. The first processor **30** calculates a color measurement value based on the amount of light associated with each wavelength. When a target color value is known in advance, the first processor **30** calculates a color difference that is the difference between the color measurement value and the target color value.

The wireless communication module **31** has a wireless communication circuit and an antenna (not illustrated). The wireless communication circuit acquires a wireless signal received from an external device via the antenna, demodulates data, and transmits the data to the first processor **30**. The wireless communication circuit acquires data from the first processor **30**, modulates a high frequency signal, and transmits a wireless signal to the external device via the antenna. For example, the wireless communication module **31** may acquire the color measurement value or the color difference calculated by the first processor **30** and transmit the color measurement value or the color difference to the external device. The wireless communication circuit may have a temperature sensor (not illustrated) and may have a function of performing temperature compensation on the color measurement value based on a signal output from the temperature sensor. The wireless communication module **31** may be, for example, a module transmitting and receiving wireless signals corresponding to wireless communication standards such as Bluetooth (registered trademark) or Wi-Fi.

The operation section **32** outputs an operation signal based on the user's operation to the first processor **30**. In the present embodiment, the operation section **32** functions as a measurement start button, and, when the user presses the operation section **32**, outputs an operation signal indicating that the operation section **32** is pressed to the first processor **30**. The first processor **30** starts a process for color measurement based on the operation signal from the operation section **32**.

The light emitting module **33** is a status display module, and emits light based on a control signal from the first processor **30**. For example, when the first processor **30** detects that the user has pressed the operation section **32**, the first processor **30** outputs a control signal for causing the light emitting module **33** to emit light.

The buzzer **34** notifies the user of various information by generating predetermined sound based on a control signal from the first processor **30**. For example, in a case where an optical axis of the light receiving element **21** is shifted or shaken significantly when the user presses the operation section **32** to start measurement, there is concern that normal color measurement may not be possible. Thus, when a failure occurs in the user's operation on operation section

32, the first processor **30** outputs a predetermined control signal to the buzzer **34**, and the buzzer **34** emits sound.

The display module **50** displays various information based on a display signal output from the first processor **30**. In the present embodiment, the light emitting module **33** includes a display panel illustrated in FIG. 2 and a display driver (not illustrated). The display panel may be, for example, a liquid crystal panel. The display driver generates a drive signal corresponding to a display signal output from the first processor **30** and outputs the drive signal to the display panel. For example, as illustrated in FIG. 2, a color measurement value, a color difference, or the like is displayed on the display panel.

The battery **70** is, for example, a secondary battery such as a lithium ion battery or a lithium polymer battery. When the user presses a power button (not illustrated), the battery **70** outputs a voltage VB according to a remaining capacity thereof.

The power source circuit **41** generates and outputs voltages V1 and V2 based on the output voltage VB of the battery **70**. The power source circuit **41** may include a step-up DCDC converter and a step-down DCDC converter (not illustrated), the step-up DCDC converter voltage may step up the output voltage VB of the battery **70** to generate the voltage V1, and the step-down DCDC converter may step down the voltage V1 to generate the voltage V2. The voltage V1 is supplied to the voltage step-up conversion circuit **26**, and the voltage V2 is supplied to the second processor **40** as a power source voltage. The voltage V2 is input to the switch circuit **42**.

The switch circuit **42** is brought into a conduction state or a non-conduction state according to a control signal from the second processor **40**. The switch circuit **42** outputs a voltage V3 that is substantially equal to the voltage V2 in a conduction state. The voltage V3 is supplied as a power source voltage to each circuit surrounded by a dashed line in FIG. 3. When the switch circuit **42** is in a non-conduction state, the voltage V3 is not supplied to each circuit. That is, the second processor **40** is a processor for power source control.

The connector **60** is a connector to which a cable is coupled, and may be, for example, a USB connector. USB stands for Universal Serial Bus. For example, the connector **60** is electrically coupled to an external device such as a personal computer via a USB cable. The second processor **40** may perform data communication with the external device via the connector **60**.

The charging circuit **43** charges the battery **70** with a power source voltage VC supplied when the connector **60** is electrically coupled to the external device.

The second processor **40** performs data communication with the first processor **30**. The second processor **40** may be started when the voltage V2 is supplied from the power source circuit **41**, and may notify the first processor **30** that the second processor **40** has been started. The first processor **30** may notify the second processor **40** that the first processor **30** transitions to a sleep mode after a color measurement process is finished, and the second processor **40** may receive the notification and bring the switch circuit **42** into a non-conduction state such that the supply of the voltage V3 to the first processor **30** is stopped.

3. Structure of Image Processing Device

Next, an internal structure of the image processing device **1** will be described in detail with reference to FIGS. 4 to 15. FIG. 4 is a diagram in which the inside of the casing **100** of the image processing device **1** is viewed from the positive direction of the X axis. FIG. 5 is a diagram in which the inside of the casing **100** of the image processing device **1** is

viewed from the positive direction of the Y axis. FIG. 6 is a diagram in which the inside of the casing 100 of the image processing device 1 is viewed from the positive direction of the Z axis.

As illustrated in FIGS. 4 and 5, the image processing device 1 has the rectangular parallelepiped casing 100, a first substrate 101, a second substrate 102, a third substrate 103, and a fourth substrate 104, and the casing 100 stores the first substrate 101, the second substrate 102, the third substrate 103, and the fourth substrate 104. Each of the first substrate 101, the third substrate 103, and the fourth substrate 104 is screwed and fixed to the casing 100. Among the first substrate 101, the second substrate 102, the third substrate 103, and the fourth substrate 104, the second substrate 102 is provided at a position closest to a bottom surface of the casing 100. The first substrate 101 is located between the second substrate 102 and the third substrate 103, and the third substrate 103 is located between the first substrate 101 and the fourth substrate 104. The fourth substrate 104 is provided at a position closest to an upper surface of the casing 100.

The wavelength variable filter 20, the light receiving element 21, the photoelectric conversion circuit 22, the amplification circuit 23, the C/V conversion circuit 24, the amplification circuit 25, the voltage step-up conversion circuit 26, and the first processor 30 illustrated in FIG. 3 are provided on the first substrate 101. The plurality of light emitting elements 10 and the light emitting element drive circuit 11 illustrated in FIG. 3 are provided on the second substrate 102. The second processor 40, the power source circuit 41, the switch circuit 42, the charging circuit 43, and the connector 60 illustrated in FIG. 3 are provided on the third substrate 103. The wireless communication module 31, the operation section 32, the light emitting module 33, and the buzzer 34 illustrated in FIG. 3 are provided on the fourth substrate 104.

As illustrated in FIGS. 4, 5 and 6, the display module 50 illustrated in FIG. 3 is located between the fourth substrate 104 and the upper surface of the casing 100, and is visually recognizable from the upper surface of the casing 100. One end of the cable 51 which is coupled to a display driver (not illustrated) built in the display module 50 is coupled to the connector 86 provided on the fourth substrate 104.

As illustrated in FIGS. 4 and 5, both ends of the flexible flat cable 91 are respectively coupled to a connector 81 provided on the first substrate 101 and a connector 87 provided on the fourth substrate 104. Signals that are input and output between the first processor 30 provided on the first substrate 101 and the wireless communication module 31, the operation section 32, the light emitting module 33, and the buzzer 34 provided on the fourth substrate 104 propagate through the flexible flat cable 91.

A display signal output from the first processor 30 provided on the first substrate 101 propagates through the flexible flat cable 91 to reach the fourth substrate 104, and further propagates through the cable 51 to reach the display module 50. Therefore, the fourth substrate 104 functions as a relay substrate that relays the display signal to the display module 50.

Both ends of the flexible flat cable 92 are respectively coupled to a connector 84 provided on the first substrate 101 and a connector 85 provided on the third substrate 103. The first processor 30 provided on the first substrate 101 and the second processor 40 provided on the third substrate 103 perform data communication via the flexible flat cable 92. The voltage V3 based on the voltage V2 generated by the power source circuit 41 provided on the third substrate 103

propagates through the flexible flat cable 92 to reach the first substrate 101, and further propagates through the flexible flat cable 91 to reach the fourth substrate 104. That is, a wiring path from the third substrate 103 to the first substrate 101 is shorter than a wiring path from the third substrate 103 to the fourth substrate 104. Therefore, the amount of drop of the voltage V3 supplied from the power source circuit 41 to the first substrate 101 becomes small, and a stable voltage is supplied to the light receiving element 21 disposed on the first substrate 101.

The first substrate 101 is provided with a connector 82, and the second substrate 102 is provided with a connector 83. The connector 82 and the connector 83 are fitted to each other, and thus the second substrate 102 is fixed to the first substrate 101, and the first substrate 101 and the second substrate 102 are electrically coupled to each other. That is, the first substrate 101 and the second substrate 102 are not coupled via a cable, but are coupled via the connector 82 and the connector 83 in a B to B manner. B to B stands for substrate to substrate. A control signal output from the first processor 30 provided on the first substrate 101 reaches the second substrate 102 via the connector 82 and the connector 83, and is input to the light emitting element drive circuit 11 provided on the second substrate 102. The connector 82 is an example of a "first connector", and the connector 83 is an example of a "second connector".

As described above, in the present embodiment, instead of the second substrate 102 provided with the light emitting element 10 and the first substrate 101 provided with the light receiving element 21 being separately fixed to the casing 100, the second substrate 102 is fixed to the first substrate 101, and the first substrate 101 is fixed to the casing 100. Therefore, even when a large force is applied when the user operates the operation section 32, relative positions of the light receiving element 21 and the light emitting element 10 are unlikely to be shifted, and thus it is possible to reduce concern that the accuracy of image processing may be lowered. In particular, since the first substrate 101 and the second substrate 102 are firmly fixed through fitting of the connector 82 and the connector 83, the relative positions of the light receiving element 21 and the light emitting element 10 are more unlikely to be shifted. Since a distance between the first substrate 101 and the second substrate 102 is shortened through fitting of the connector 82 and the connector 83, the casing 100 can be miniaturized. The second substrate 102 may be fixed to the first substrate 101 by means other than B to B coupling, for example, screwing. In this case, the first substrate 101 and the second substrate 102 may be electrically coupled via a cable.

As illustrated in FIGS. 4 and 5, the battery 70 illustrated in FIG. 3 is located between the first substrate 101, the second substrate 102, the third substrate 103, and the fourth substrate 104. More specifically, the battery 70 is provided between the third substrate 103 and the fourth substrate 104. The third substrate 103 is provided between the battery 70 and the first substrate 101. The battery 70 overlaps the third substrate 103 in a Z axis direction orthogonal to a surface 101F of the first substrate 101. Therefore, the first substrate 101, the second substrate 102, the third substrate 103, the fourth substrate 104, and the battery 70 overlap each other in a plan view viewed from the positive direction of the Z axis. A space in which the first substrate 101, the second substrate 102, and the third substrate 103 are disposed and a space in which the fourth substrate 104 is disposed are separated by the battery 70.

As illustrated in FIG. 4, the battery 70 has a rectangular shape in a plan view viewed from the positive direction of

the X axis. On the other hand, as illustrated in FIG. 5, in a plan view viewed from the positive direction of the Y axis, a portion of the battery 70 facing the fourth substrate 104 has a semicircular shape, and a portion thereof facing the first substrate 101, the second substrate 102, and the third substrate 103 has a trapezoidal shape in which the upper bottom is longer than the lower bottom. Therefore, the portion of the battery 70 facing the first substrate 101, the second substrate 102, and the third substrate 103 has a smaller sectional area as the battery 70 becomes closer to the first substrate 101, the second substrate 102, and the third substrate 103. Thus, a gap is formed between the battery 70 and the third substrate 103 in the X axis direction, and the connectors 71 and 72 are provided on the third substrate 103 by utilizing this gap. The connectors 71 and 72 are coupled to the battery 70 via a wiring (not illustrated). The power source circuit 41 and the charging circuit 43 illustrated in FIG. 3 are electrically coupled to the battery 70 via the connectors 71 and 72.

FIG. 7 is a diagram in which the first substrate 101 is viewed from the positive direction of the Z axis, and FIG. 8 is a sectional view of the first substrate 101 taken along the line VIII-VIII IN FIG. 7. As illustrated in FIG. 7, in a plan view viewed from the positive direction of the Z axis, the first substrate 101 has a rectangular shape having a side 101a, a side 101b longer than the side 101a, a side 101c opposite to the side 101a, and a side 101d opposite to the side 101b.

As illustrated in FIGS. 7 and 8, the first substrate 101 has a surface 101F that faces the positive direction of the Z axis and a surface 101R that faces the negative direction of the Z axis. The first substrate 101 is provided between the third substrate 103 and the second substrate 102 in the Z axis direction. The light receiving element 21 is provided on the surface 101R of the first substrate 101.

As illustrated in FIG. 7, the first substrate 101 is configured by fixing a main substrate 111 and a sub-substrate 113 to a spacer substrate 112 with screws 131 and 132.

FIG. 9 is a diagram in which the sub-substrate 113 is viewed from the positive direction of the Z axis. FIG. 10 is a diagram in which the spacer substrate 112 is viewed from the positive direction of the Z axis. FIG. 11 is a diagram in which the main substrate 111 is viewed from the positive direction of the Z axis. In FIGS. 9, 10 and 11, a solid line indicate a constituent provided on the surface of each substrate facing the positive direction of the Z axis, and a dashed line indicates a constituent provided on the surface of each substrate facing the negative direction of the Z axis.

As illustrated in FIGS. 7, 9, 10 and 11, screws 131 are inserted into a screw hole 121 provided in the main substrate 111, a screw hole 123 provided in the spacer substrate 112, and a screw hole 124 provided in the sub-substrate 113, and screws 132 are inserted into a screw hole 122 provided in the main substrate 111 and a screw hole 125 provided in the sub-substrate 113.

As illustrated in FIG. 9, the sub-substrate 113 has a surface 113F that faces the positive direction of the Z axis and a surface 113R that faces the negative direction of the Z axis. The surfaces 101F and 101R of the first substrate 101 are respectively the surfaces 113F and 113R of the sub-substrate 113. As illustrated in FIGS. 8 and 9, the light receiving element 21 and the amplification circuit 23 are provided on the surface 113R of the sub-substrate 113.

As illustrated in FIGS. 7 and 11, in a plan view viewed from the positive direction of the Z axis, an outer shape of the first substrate 101 coincides with an outer shape of the main substrate 111, and the side, 101a, the side 101b, the side 101c, and the side 101d of the first substrate 101 are

respectively the side 111a, the side 111b, the side 111c, and the side 111d of the main substrate 111.

As illustrated in FIG. 11, the main substrate 111 has a surface 111F that faces the positive direction of the Z axis and a surface 111R that faces the negative direction of the Z axis. The photoelectric conversion circuit 22, the amplification circuit 25, the voltage step-up conversion circuit 26, the first processor 30, and the connector 84 are provided on the surface 111F of the main substrate 111. The wavelength variable filter 20, the C/V conversion circuit 24, the connector 81, and the connector 82 are provided on the surface 111R of the main substrate 111. As illustrated in FIGS. 8 and 11, the main substrate 111 has a rectangular opening 120, and the wavelength variable filter 20 and the opening 120 overlap each other in a plan view viewed from the positive direction of the Z axis.

In the present embodiment, the first substrate 101 includes three substrates such as the main substrate 111, the spacer substrate 112, and the sub-substrate 113, but may include one or two substrates.

FIG. 12 is a diagram in which the second substrate 102 is viewed from the positive direction of the Z axis. In FIG. 12, a solid line indicates a constituent provided on the surface 102F of the second substrate 102 facing the positive direction of the Z axis, and a dashed line indicates a constituent provided on the surface 102R of the second substrate 102 facing the negative direction of the Z axis.

As illustrated in FIG. 12, in a plan view viewed from the positive direction of the Z axis, the second substrate 102 has a rectangular shape having a side 102a, a side 102b longer than the side 102a, a side 102c opposite to the side 102a, and a side 102d opposite to the side 102b. The connector 83 is provided on the surface 102F of the second substrate 102. The surface 102F of the second substrate 102 faces the surface 101R of the first substrate 101.

The plurality of light emitting elements 10 and the light emitting element drive circuit 11 are provided on the surface 102R of the second substrate 102. The second substrate 102 has a circular opening 140, and the plurality of light emitting elements 10 are provided on the surface 102R of the second substrate 102 to surround the opening 140 in a plan view viewed from the positive direction of the Z axis. The surface 102R of the second substrate 102 faces the inner wall surface of the casing 100.

FIG. 13 is a diagram in which the third substrate 103 is viewed from the positive direction of the Z axis. In FIG. 13, the solid line shows the constituents provided on the surface 103F of the third substrate 103 facing the positive direction of the Z axis, and the dashed line is provided on the surface 103R of the third substrate 103 facing the negative direction of the Z axis. The constituents are illustrated.

As illustrated in FIG. 13, in a plan view viewed from the positive direction of the Z axis, the third substrate 103 has a rectangular shape having a side 103a, a side 103b longer than the side 103a, a side 103c opposite to the side 103a, and a side 103d opposite to the side 103b. The second processor 40, the power source circuit 41, the switch circuit 42, the charging circuit 43, the connector 60, the connector 71, and the connector 72 are provided on the surface 103F of the third substrate 103. The surface 103F of the third substrate 103 faces the battery 70.

The connector 85 is provided on the surface 103R of the third substrate 103. The surface 103R of the third substrate 103 faces the surface 101F of the first substrate 101.

FIG. 14 is a diagram in which the fourth substrate 104 is viewed from the positive direction of the Z axis. In FIG. 14, a solid line indicates a constituent provided on the surface

11

104F of the fourth substrate 104 facing the positive direction of the Z axis, and a dashed line indicates a constituent provided on the surface 104R of the fourth substrate 104 facing the negative direction of the Z axis.

As illustrated in FIG. 14, in a plan view viewed from the positive direction of the Z axis, the fourth substrate 104 has a rectangular shape having a side 104a, a side 104b longer than the side 104a, a side 104c opposite to the side 104a, and a side 104d opposite to the side 104b.

The operation section 32, the light emitting module 33, the buzzer 34, and the connector 86 are provided on the surface 104F of the fourth substrate 104. The operation section 32 is provided on the surface 104F of the fourth substrate 104 at a position overlapping a virtual line VL equidistant from the side 104b and the side 104d. That is, the operation section 32 is disposed at the center of the fourth substrate 104 in the short side direction. The operation section 32 is, for example, a button that is physically displaced when pressed by the user. The operation section 32 may be a capacitance type button.

The surface 104F of the fourth substrate 104 faces the inner wall surface of the casing 100 and the display module 50.

The wireless communication module 31 and the connector 87 are provided on the surface 104R of the fourth substrate 104. The wireless communication module 31 is provided in an end region of the surface 104R of the fourth substrate 104. The end region is a region closest to the side 104a when the entire region of the surface 104R of the fourth substrate 104 is divided into three regions having the same area by two line segments parallel to the side 104a. The surface 104R of the fourth substrate 104 faces the battery 70.

FIG. 15 is a diagram in which the plurality of light emitting elements 10, the wavelength variable filter 20, the light receiving element 21, the opening 140, the first processor 30, the wireless communication module 31, the operation section 32, the power source circuit 41, the display module 50, and the fourth substrate 104 are viewed from the positive direction of the Z axis.

As illustrated in FIG. 15, in the Z axis direction, the opening 140 of the second substrate 102, the wavelength variable filter 20, and the light receiving element 21 overlap each other, and the plurality of light emitting elements 10 are located to surround the opening 140. That is, the opening 140 and the wavelength variable filter 20 overlap on the optical axis of the light receiving element 21, and the plurality of light emitting elements 10 are located to surround the optical axis of the light receiving element 21. Therefore, light emitted from the plurality of light emitting elements 10 is reflected at the image IMG, and the reflected light passes through the opening 140 and is incident to the wavelength variable filter 20. Light having a predetermined wavelength that has transmitted through the wavelength variable filter 20 is incident to the light receiving element 21. The constituents of the optical system are disposed to overlap each other in the Z axis direction in the above-described way, so that a space required for the optical system can be reduced and the casing 100 can be miniaturized.

As illustrated in FIG. 15, the operation section 32 and a region A1 in which the plurality of light emitting elements 10 are disposed are provided at a position where they overlap on the optical axis of the light receiving element 21. Therefore, when the user operates the operation section 32, a force is applied straight to the optical axis of the light receiving element 21, and thus the optical axis of the light receiving element 21 is unlikely to be shaken or shifted with

12

respect to the image IMG. In the present embodiment, since the plurality of light emitting elements 10 are provided on the surface 102R of the second substrate 102 to surround the opening 140, the region A1 is a region of the smallest circle including each disposition region of the plurality of light emitting elements 10.

As illustrated in FIG. 15, the display module 50 and the wireless communication module 31 do not overlap each other in the Z axis direction orthogonal to the surface 101R of the fourth substrate 104 on which the wireless communication module 31 is provided. Therefore, it is possible to reduce concern that the reception sensitivity of the wireless communication module 31 is lowered due to the display module 50.

As illustrated in FIG. 15, the first processor 30 and the light receiving element 21 do not overlap the power source circuit 41 in the Z axis direction. Therefore, it is possible to reduce concern that the characteristics of the light receiving element 21 may change due to heat generated by the power source circuit 41, and to increase the heat dissipation of the power source circuit 41, the first processor 30, and the light receiving element 21, each of which is a heat source.

4. Advantageous Effects

The image processing device 1 of the present embodiment includes the battery 70 and can be carried or operated independently, but in order to solve at least one of various problems caused thereby, various ideas regarding disposition of each constituent have been devised.

One of objects is to reduce concern that a defect may occur due to heat generated in a narrow space inside the small casing 100. In the image processing device 1 of the present embodiment, the light receiving element 21 and the first processor 30 that are operated during an image processing period and may serve as heat generation sources are disposed on the first substrate 101. The plurality of light emitting elements 10 and a light emitting element drive circuit 11 that are operated during the image processing period and may serve as heat generation sources are disposed on the second substrate 102. The power source circuit 41 and the second processor 40 that are operated during the image processing period and may serve as heat generation sources are disposed on the third substrate 103. As described above, in the image processing device 1 of the present embodiment, since the respective constituents that may serve as heat generation sources are provided on the first substrate 101, the second substrate 102, and the third substrate 103 in a distributed manner, mutual thermal influence can be reduced and thus an operation can be stabilized.

Since the power source circuit 41 does not overlap the light receiving element 21 in the Z axis direction, concern that the characteristics of the light receiving element 21 may change due to the heat generated by the power source circuit 41 is reduced, and heat dissipation of each of the power source circuit 41 and the light receiving element 21 is increased. Therefore, according to the image processing device 1, it is possible to reduce concern that the accuracy of image processing performed based on an amount of light received by the light receiving element 21 may be lowered, and thus to continuously perform an operation for a long time while ensuring a constant quality.

According to the image processing device 1, since the first processor 30 that may serve as a heat generation source does not overlap the power source circuit 41 in the Z axis direction, heat dissipation of each of the first processor 30 and the power source circuit 41 is increased.

In the image processing device 1, the wireless communication module 31 is provided on the fourth substrate 104

different from the first substrate **101**, the second substrate **102**, and the third substrate **103** respectively provided with the light receiving element **21**, the plurality of light emitting elements **10**, and the power source circuit **41**, which may serve as heat generation sources. Therefore, according to the image processing device **1**, concern that the wireless communication module **31** required to be stably operated may malfunction due to the influence of heat is reduced.

In the image processing device **1**, the battery **70** located between the first substrate **101**, the second substrate **102**, and the third substrate **103**, and the fourth substrate **104** functions as a heat barrier, and thus heat generated from the first substrate **101**, the second substrate **102**, and the third substrate **103** is unlikely to be transmitted to the fourth substrate **104**. Therefore, according to the image processing device **1**, the wireless communication module **31** provided on the fourth substrate **104** is unlikely to be influenced by a sudden temperature rise of the first substrate **101**, the second substrate **102**, and the third substrate **103** due to the image processing, and thus it is possible to ensure a stable communication quality.

As illustrated in FIG. 5, in the image processing device **1**, since the portion of the battery **70** facing the first substrate **101**, the second substrate **102**, and the third substrate **103** have a small sectional area, a gap between the battery **70** and the first substrate **101**, the second substrate **102**, and the third substrate **103** is larger than when a rectangular parallelepiped battery is disposed. Therefore, according to the image processing device **1**, heat from the first substrate **101**, the second substrate **102**, and the third substrate **103** respectively provided with the light receiving element **21**, the plurality of light emitting elements **10**, and the power source circuit **41**, which may serve as heat generation sources easily diffuses and thus heat dissipation is improved.

The fourth substrate **104** is provided with the wireless communication module **31** and the light emitting module **33** having a small amount of generated heat because they are operated only for a short period of time when necessary, and the operation section **32** and the buzzer **34** that generate almost no heat. Thus, although the fourth substrate **104** generates heat because the fourth substrate **104** relays a display signal to the display module **50** during the image processing period, at least one of the first substrate **101**, the second substrate **102**, and the third substrate **103** generates a larger amount of heat than the fourth substrate **104**. In fact, unless a special situation such as frequent wireless communication occurs, the first substrate **101**, the second substrate **102**, and the third substrate **103** all generate a larger amount of heat than the fourth substrate **104**. As described above, in the image processing device **1**, respective constituents having a relatively large amount of generated heat is disposed on the first substrate **101**, the second substrate **102**, and the third substrate **103** having high heat dissipation, and each constituent having a relatively small amount of generated heat is disposed on the fourth substrate **104** that is unlikely to be influenced by heat. Therefore, according to the image processing device **1**, it is possible to improve the heat dissipation while securing the capacity of the battery **70**, and thus an operation can be continuously performed for a long time while ensuring a constant quality.

According to the image processing device **1**, since the first processor **30** that may serve as a heat generation source is provided on the first substrate **101** having good heat dissipation, an operation can be continuously performed for a long time while ensuring a constant quality.

According to the image processing device **1**, since the second processor **40** that may serve as a heat generation

source is provided on the third substrate **103** having good heat dissipation, an operation can be continuously performed for a long time while ensuring a constant quality.

One of the objects is also to achieve favorable noise resistance or responsiveness. In the image processing device **1** of the present embodiment, since the first processor **30** that performs image processing is provided on the first substrate **101** provided with the light receiving element **21**, a signal output from the light receiving element **21** propagates toward the first processor **30** without passing through the second substrate **102**, the third substrate **103**, and the fourth substrate **104**. Therefore, according to the image processing device **1**, it is possible to realize favorable noise resistance or responsiveness.

In the image processing device **1**, since the second processor **40** that performs power source control is provided on the third substrate **103** provided with the power source circuit **41**, a signal output from the second processor **40** propagates toward the power source circuit **41** without passing through the other substrates. Therefore, according to the image processing device **1**, it is possible to realize favorable noise resistance or responsiveness.

According to the image processing device **1**, the wireless communication module **31** is disposed in the end region of the fourth substrate **104** in the long side direction in which a distance from the inner wall surface of the casing **100** is small, and is thus unlikely to be influenced by noise such that the communication sensitivity can be increased.

According to the image processing device **1**, since the light receiving element **21**, the plurality of light emitting elements **10**, the power source circuit **41**, the wireless communication module **31**, and the operation section **32** are respectively provided on different substrates, mutual interference of heat, vibration, signals, and the like is reduced, and thus an operation can be stabilized. Therefore, according to the image processing device **1**, it is possible to reduce concern that the accuracy of image processing may be lowered due to mutual interference of heat, vibration, signals, and the like between a plurality of constituents is reduced, and thus to continuously perform an operation for a long time while ensuring a constant quality.

In the image processing device **1**, since the wiring path from the third substrate **103** to the first substrate **101** is short, an amount of drop in the voltage **V3** supplied from the power source circuit **41** disposed on the third substrate **103** to the first substrate **101** is small. Therefore, according to the image processing device **1**, a stable voltage is supplied to the light receiving element **21** disposed on the first substrate **101**, and thus concern that the accuracy of image processing may be lowered is reduced.

According to the image processing device **1**, since the wiring path between the light receiving element **21** and the photoelectric conversion circuit **22** is short and thus the influence of noise on a minute signal is reduced, concern that the accuracy of image processing may be lowered is reduced.

According to the image processing device **1**, since the wireless communication module **31** does not overlap the display module **50** in the direction orthogonal to the fourth substrate **104**, concern that the reception sensitivity may be lowered by the display module **50** is reduced.

One of the objects is also to improve user's operability and convenience. In the image processing device **1** of the present embodiment, the first substrate **101** is provided between the third substrate **103** and the second substrate **102** in the Z axis direction, the third substrate **103** is provided between the battery **70** and the first substrate **101**, the battery

15

70 is located between the third substrate 103 and the fourth substrate 104, and the battery 70 overlaps the third substrate 103. Therefore, according to the image processing device 1, the second substrate 102, the first substrate 101, the third substrate 103, the battery 70, and the fourth substrate 104 are disposed to overlap each other in this order, and thus a width of the casing 100 in the X axis direction and the Y axis direction can be made smaller than a height thereof in the Z axis direction. Therefore, a user can easily recognize a position of the light receiving element 21, and thus the operability of the image processing device 1 is improved.

According to the image processing device 1, in the Z axis direction, the opening 140 of the second substrate 102, the wavelength variable filter 20, and the light receiving element 21 overlap each other, and the plurality of light emitting elements 10 are located to surround the opening 140. As a result, a space required for disposing the optical system is reduced such that the casing 100 can be miniaturized.

In the image processing device 1, since the operation section 32 and the buzzer 34 that generate almost no heat and the light emitting module 33 that generates a small amount of heat have almost no effect on the communication quality, the operation section 32, the buzzer 34, and the light emitting module 33 are disposed on the fourth substrate 104 provided with the wireless communication module 31, and thus a region of the fourth substrate 104 is effectively utilized. Since the display module 50 having a smaller amount of generated heat than that of the first substrate 101, the second substrate 102, and the third substrate 103 has the small effect on the communication quality, the fourth substrate 104 on which the wireless communication module 31 is disposed is also used as a relay substrate that relays a display signal to the display module 50. Therefore, according to the image processing device 1, the casing 100 can be miniaturized and a user's operability can be improved.

In the image processing device 1, the second substrate 102 provided with the light emitting element 10 is fixed to the first substrate 101 provided with the light receiving element 21, and the first substrate 101 is fixed to the casing 100. Therefore, according to the image processing device 1, even though a large force is applied when a user operates the operation section 32, relative positions of the light receiving element 21 and the light emitting element 10 are unlikely to be shifted, and thus concern that the accuracy of image processing may be lowered is reduced.

According to the image processing device 1, since the first substrate 101 and the second substrate 102 are firmly fixed to each other through fitting of the connector 82 and the connector 83, relative positions of the light receiving element 21 and the light emitting element 10 are more unlikely to be shifted. According to the image processing device 1, since the first substrate 101 and the second substrate 102 are electrically coupled to each other through fitting of the connector 82 and the connector 83, a distance between the first substrate 101 and the second substrate 102 is short such that the casing 100 can be miniaturized and a user's operability can be improved.

In the image processing device 1, the operation section 32 provided on the fourth substrate 104, the region A1 of the second substrate 102 on which the plurality of light emitting elements 10 are disposed, and the light receiving element 21 overlap each other on the optical axis of the light receiving element 21. Therefore, when a user operates the operation section 32, a force is applied straight to the optical axis of the light receiving element 21. Therefore, according to the image processing device 1, when the user operates the operation section 32, the optical axis of the light receiving

16

element 21 is unlikely to be shaken or shifted with respect to the image IMG that is a processing target, and a probability that normal data can be acquired is increased.

For example, when the operation section 32 is a button that is physically displaced, since the operation section 32 is physically displaced by a user's operation, it is possible to reliably recognize that the user has performed the operation, and, although a large force is applied by the user's operation, the optical axis of the light receiving element 21 is unlikely to be shaken or shifted.

For example, in a case where the operation section 32 is a capacitance type button, since an operation is detected when a user touches the operation section 32, a force applied by the user's operation is small and the optical axis of the light receiving element 21 is more unlikely to be shaken or shifted.

According to the image processing device 1, since the operation section 32 is disposed at the center of the fourth substrate 104 in the short side direction, it is easy for a user to operate the operation section 32 and the operability is improved. Since the operability is improved, when the user operates the operation section 32, the optical axis of the light receiving element 21 is more unlikely to be shaken or shifted with respect to the image IMG that is a processing target.

According to the image processing device 1, since a user can recognize that the operation section 32 is operated according to a light emitting state of the light emitting module 33 without applying an unnecessarily large force, an amount of shake or shift of the optical axis of the light receiving element 21 is reduced, and thus a probability that normal data can be acquired is improved.

According to the image processing device 1, a user can recognize that an operation failure has occurred based on buzzer sound and can quickly perform an operation of the operation section 32 again, and thus the user's convenience is improved.

According to the image processing device 1, the image processing device 1 can be operated independently without receiving an instruction from another device and can be carried that is thus highly convenient for the user.

One of the objects is also to improve maintainability. In the image processing device 1 of the present embodiment, the light receiving element 21, the plurality of light emitting elements 10, the power source circuit 41, and the wireless communication module 31 and the operation section 32 are respectively provided on different substrates. Therefore, according to the image processing device 1 of the present embodiment, when any one of the light receiving element 21, the plurality of light emitting elements 10, the power source circuit 41, the wireless communication module 31, and the operation section 32 fails, maintainability is good because one substrate needs only be replaced and the other three substrates do not need to be replaced.

According to the image processing device 1, since the light emitting element drive circuit 11 and the plurality of light emitting elements 10 are provided on the second substrate 102, when at least one thereof fails, the second substrate 102 may be replaced with a substrate of which characteristics have been inspected by combining another light emitting element drive circuit and other light emitting elements, and thus maintainability is good.

According to the image processing device 1, since the light receiving element 21 and the photoelectric conversion circuit 22 are provided on the sub-substrate 113 of the first substrate 101, when at least one thereof fails, the sub-substrate 113 of the first substrate 101 may be replaced with a substrate of which characteristics have been inspected by

combining another light receiving element and another photoelectric conversion circuit, and thus maintainability is good.

As described above, according to the image processing device **1** of the present embodiment, it is possible to solve at least one of various problems that are likely to occur because the battery **70** is provided and the image processing device **1** can be carried or operated independently.

The present disclosure is not limited to the present embodiment, and various modifications can be made within the scope of the spirit of the present disclosure.

For example, as an image processing device according to the present disclosure, a color measurement device has been described as an example in the above embodiment, but the present disclosure is applicable to various image processing devices having a function of processing an image in addition to the color measurement device. Examples of image processing devices to which the present disclosure is applicable include mobile terminals such as smartphones, portable printers, portable scanners, portable display devices, and digital cameras.

Although the present embodiment or the modification examples have been described above, the present disclosure is not limited to the present embodiment or the modification example, and can be implemented in various aspects without departing from the spirit thereof. For example, each of the embodiments and each of the modification examples may be combined as appropriate.

The present disclosure includes a configuration that is substantially the same as the configuration described in the embodiment, for example, a configuration having the same function, method, and result, or a configuration having the same object and effect. The present disclosure also includes a configuration in which a non-essential part of the configuration described in the embodiment is replaced. The present disclosure also includes a configuration that can achieve the same advantageous effect as that of the configuration described in the embodiment or a configuration that can achieve the same object. The present disclosure includes a configuration in which a well-known technique is added to the configuration described in the embodiment.

The following details are derived from the above-described embodiments and modification examples.

According to one aspect, an image processing device includes a light receiving element; a light emitting element; a battery; a power source circuit electrically coupled to the battery; an operation section; a wireless communication module; a first substrate provided with the light receiving element; a second substrate provided with the light emitting element; a third substrate provided with the power source circuit; a fourth substrate provided with the wireless communication module and the operation section; and a casing storing the first substrate, the second substrate, the third substrate, and the fourth substrate, in which the second substrate is fixed to the first substrate, and the first substrate is fixed to the casing.

In this image processing device, since the light receiving element, the light emitting element, the power source circuit, the wireless communication module, and the operation section are respectively provided on different substrates, mutual interference of heat, vibration, signals, and the like is reduced and thus an operation can be stabilized. Therefore, according to this image processing device, concern that the accuracy of image processing may be lowered due to mutual interference of heat, vibration, signals, and the like between a plurality of constituents is reduced, and thus an operation can be continuously performed for a long time

while ensuring a constant quality. According to this image processing device, when any one of the light receiving element, the light emitting element, the power source circuit, the wireless communication module, and the operation section fails, maintainability is good because one substrate needs only be replaced and the other three substrates do not need to be replaced.

According to this image processing device, since the second substrate provided with the light emitting element is fixed to the first substrate provided with the light receiving element, even though a large force is applied when a user operates the operation section, relative positions of the light receiving element and the light emitting element are unlikely to be shifted, and thus concern that the accuracy of image processing may be lowered is reduced.

In the aspect of the image processing device, a first connector may be provided on the first substrate, a second connector may be provided on the second substrate, and the second substrate may be fixed to the first substrate and the first substrate and the second substrate may be electrically coupled to each other through fitting of the first connector and the second connector.

According to this image processing device, the first substrate and the second substrate are firmly fixed through fitting of the first connector and the second connector, and thus the relative positions of the light receiving element and the light emitting element are more unlikely to be shifted. According to this image processing device, since the first substrate and the second substrate are electrically coupled to through fitting of the first connector and the second connector, a distance between the first substrate and the second substrate is short. Therefore, the casing can be miniaturized and a user's operability can be improved.

In the aspect of the image processing device, a wiring path from the third substrate to the first substrate may be shorter than a wiring path from the third substrate to the fourth substrate.

In this image processing device, since the wiring path from the third substrate to the first substrate is short, an amount of drop in a voltage supplied from the power source circuit disposed on the third substrate to the first substrate is small. Therefore, according to this image processing device, since a stable voltage is supplied to the light receiving element disposed on the first substrate, concern that the accuracy of image processing may be lowered is reduced.

According to the aspect, the image processing device may further include a light emitting element drive circuit that drives the light emitting element, in which the light emitting element drive circuit may be provided on the second substrate.

According to this image processing device, since the light emitting element drive circuit and the light emitting element are provided on the second substrate, when at least one thereof fails, the second substrate may be replaced with a substrate of which characteristics have been inspected by combining another light emitting element drive circuit and other light emitting elements, and thus maintainability is good.

According to the aspect, the image processing device may further include a photoelectric conversion circuit that converts an amount of light received by the light receiving element into an electrical signal, in which the photoelectric conversion circuit may be provided on the first substrate.

According to this image processing device, a wiring path between the light receiving element and the photoelectric conversion circuit is short, and the influence of noise on a minute signal is reduced, and thus concern that the accuracy

19

of image processing may be lowered is reduced. According to this image processing device, since the light receiving element and the photoelectric conversion circuit are provided on the first substrate, when at least one thereof fails, the first substrate may be replaced with a substrate of which characteristics have been inspected by combining another light receiving element and another photoelectric conversion circuit, and thus maintainability is good.

What is claimed is:

1. An image processing device comprising:

- a light receiving element;
- a light emitting element;
- a battery;
- a power source circuit electrically coupled to the battery; an operation section;
- a wireless communication module;
- a first substrate provided with the light receiving element;
- a second substrate provided with the light emitting element;
- a third substrate provided with the power source circuit;
- a fourth substrate provided with the wireless communication module and the operation section; and
- a casing storing the first substrate, the second substrate, the third substrate, and the fourth substrate, wherein the second substrate is fixed to the first substrate, and the first substrate is fixed to the casing.

2. The image processing device according to claim 1, wherein

20

a first connector is provided on the first substrate, a second connector is provided on the second substrate, and

the second substrate is fixed to the first substrate and the first substrate and the second substrate are electrically coupled to each other through fitting of the first connector and the second connector.

3. The image processing device according to claim 1, wherein

a wiring path from the third substrate to the first substrate is shorter than a wiring path from the third substrate to the fourth substrate.

4. The image processing device according to claim 1, further comprising:

a light emitting element drive circuit that drives the light emitting element, wherein the light emitting element drive circuit is provided on the second substrate.

5. The image processing device according to claim 1, further comprising:

a photoelectric conversion circuit that converts an amount of light received by the light receiving element into an electrical signal, wherein

the photoelectric conversion circuit is provided on the first substrate.

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